



UNIVERSITI PUTRA MALAYSIA

**BEHAVIOURAL RESPONSES OF TRICHOGRAMMA PAPILIONIS
NAGARKATTI, EGG PARASITOID OF MAIZE BORER, OSTRINIA
FURNACALIS (GUEN.) TO SEMIOCHEMICALS FROM MAIZE PLANT
AND SELECTED WEEDS**

SARIPAH ULPAH.

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MAIZE PLANT AND SELECTED WEEDS**

**By
SARIPAH ULPAH**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirement for the Degree of Doctor of Philosophy**

February 2006



I dedicate this work to all of my big family

ESPECIALLY

*my beloved husband and my kids
for your prayers, love and understanding*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Doctor of Philosophy

**BEHAVIOURAL RESPONSES OF *TRICHOGRAMMA PAPILIONIS*
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February 2006

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Manipulation of parasitoid behaviour for the purposes of habitat location and host finding could optimise the utilisation of biological control agents in pest management. In order to be able to do so, factors that elicit such behavioural responses of the parasitoid need to be elucidated. As such, members of the first trophic level, i.e maize and associated weeds, were investigated for possible semiochemicals by determining their attractancy, arrestant and activation effects of the plant chemicals to the third trophic level, i.e. *Trichogramma papilionis* Nagarkatti, the egg parasitoid of the Asiatic maize-borer, *Ostrinia furnacalis* (Guen.).

Attractancy effects of volatile plant chemicals of selected weeds and extracts of maize leaf of various growth stages were studied using a modified linear olfactometer. Contact effects of plant chemicals on the retention time of *T. papilionis* were investigated in a glass cylinder arena, and by tracing the locomotion of female parasitoid upon encountering plant chemical patch. Effects of plants chemicals on parasitization rate by *T. papilionis* were evaluated in Petri-dish and in cage experiment. Effects of stimulation from plant chemicals prior to parasitoid release was studied in the laboratory. A Field trial was conducted to probe the response of naturally occurring *Trichogramma* to the extracts of *Amaranthus hybridus*, a weed species found to elicit positive response in *T. papilionis*.

The weeds studied were *Ageratum conyzoides*, *Amaranthus hybridus*, *Asystasia gangetica*, *Borreria latifolia*, *Cleome rutidosperma*, *Cyperus rotundus* and *Eleusine indica*.

Results of experiments using linear olfactometer revealed that volatiles from fresh plant material of *A. gangetica*, *C. rutidosperma* and *A. hybridus* showed attractancy effects, on the contrary, that of *A. conyzoides* showed repellent effect, while those of *B. latifolia*, *C. rotundus* and *E. indica* did not elicit significant response to the parasitoid compared to control. Extracts of maize leaf at early-whorl stage did not cause significant difference in *T.*

papilionis rate of displacement at concentrations 0.005 g/ml and 0.05 g/ml; extract of maize leaf from tasseling/silking stages, however, elicited significant responses at both concentrations tested.

Through contact effect studies, extracts of early-whorl stage at all concentration tested (0.001, 0.01, and 0.03 g/ml), did not result in the increase of retention time by the female parasitoid. However, increasing the extract concentration of other maize stages generally increased the retention time of the parasitoid. Silking stage at 0.03 g/ml revealed highly significant difference. Surface extract of *A. hybridus* resulted in significantly higher retention time at all concentration tested (1, 2 and 3 g/ml). The extract from *C. rutidosperma* did not cause any significant difference at all concentration tested, while that of *A. gangetica* gave significant difference only at the highest concentration. Extract of *Ageratum*, however, caused significantly reduced retention time.

Female parasitoids that were allowed to oviposit prior to being used in the experiment showed extended retention time in Petri dish testing. Parasitization experiments revealed that the extracts of maize leaves and of two weeds, *A. gangetica*, and *A. hybridus*, significantly increased the parasitization of *Corcyra cephalonica* eggs by the *T. papilionis*. Pre-release

stimulation using the extracts of maize and *A. hybridus* increased parasitization rates. In field trials inconclusive results were obtained due to the unusually low parasitoid number during the experiment. However, the performance of *Trichogramma* in the field seemed to be enhanced with the application of *A. hybridus* extract.

It is concluded that *T. papilionis* seemed to be adaptive to chemicals from maize, the host plant of its natural host, *O. furnacalis*. The response, however, varied depending on plant stage of plant growth. *Trichogramma papilionis* showed positive responses to chemicals from *A. hybridus* which were comparable to those caused by maize leaves extracts. Since response of the parasitoid varied among weeds present in maize field ecosystem, selective weeding would be able to enhance the parasitoid performance. *Amaranthus hybridus* showed the prospect to be utilised for manipulation of the parasitoid foraging behaviour, for the purpose of the maize borer control, and the possibility of bridging the *T. papilionis* to other lepidopteran pest in other crop system. The methods, however, need further refinement.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**TANGGAP PERILAKU *TRICHOGRAMMA PAPILIONIS* NAGARKATTI,
PARASITOID TELUR DARI PENGOREK BATANG JAGUNG,
OSTRINIA FURNACALIS (GUEN.), TERHADAP SEMIOKIMIA DARI
TANAMAN JAGUNG DAN BEBERAPA RUMPAI TERPILIH**

Oleh

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Manipulasi perilaku parasitoid untuk tujuan penetapan habitat dan penemuan perumah dapat mengoptimumkan kepenggunaan agen kawalan biologi di dalam pengurusan perosak. Agar dapat melakukan hal itu, faktor-faktor yang menyebabkan penghasilan perilaku dari parasitoid perlu diperjelaskan. Oleh itu, semiokimia tumbuhan dari trofik aras pertama, seperti tanaman jagung dan rumpai yang bersekutu telah dikaji dengan cara menentukan pengaruh ketertarikan, penahanan dan keaktifan semiokimia tersebut terhadap ahli trofik aras ketiga seperti *Trichogramma papilionis* Nagarkatti, parasitoid telur dari pengorek batang jagung Asia, *Ostrinia furnacalis* (Guen.).

Pengaruh ketertarikan kimia tumbuhan yang bersifat meruap dari beberapa rumpai dan ekstrak daun jagung dari berbagai peringkat tumbesaran dikaji dengan menggunakan olfaktometer lurus yang telah diubah suai. Kesan kontak kimia tumbuhan terhadap masa pengekalan penahanan of *T. papilionis* dikaji di dalam arena silinder kaca, dan dengan menjejaki pergerakan parasitoid betina ketika menemui tompok kimia tumbuhan. Pengaruh kimia tumbuhan terhadap daya pemparasitan *T. papilionis* dikaji di dalam piring dan di dalam kurungan. Kajian pengaruh rangsangan sebelum penglepasan parasitoid telah dilakukan di dalam makmal. Kajian lapangan telah dilakukan untuk mengetahui respon *Trichogramma* yang terdapat secara asli terhadap ekstrak *Amaranthus hybridus*, satu spesies rumpai yang telah didapati menghasilkan respon positif daripada *T. papilionis*

Jenis-jenis rumpai yang dikaji meliputi *Ageratum conyzoides*, *Amaranthus hybridus*, *Asystasia gangetica*, *Borreria latifolia*, *Cleome rutidosperma*, *Cyperus rotundus* dan *Eleusine indica*.

Kajian menggunakan olfaktometer lurus mendedahkan bahawa kandungan meruap dari bahan tanaman *A. gangetica*, *C. rutidosperma* dan *A. hybridus* menunjukkan pengaruh ketertarikan, akan tetapi kandungan meruap dari tanaman *A. conyzoides* menunjukkan pengaruh penolakan, sementara dari *B.*

latifolia, *C. rotundus* dan *E. indica* tidak menghasilkan respon yang bererti kepada parasitoid berbanding kawalan. Ekstrak daun jagung dari peringkat puser awal tidak menyebabkan perbezaan bererti dalam kepantasan pergerakan *T. papilionis* untuk kepekatan 0.005 g/ml dan 0.05 g/ml; pun begitu ekstrak dari peringkat berbunga jantan/berjambul menyebabkan perbezaan respon yang bererti untuk kedua-dua kepekatan yang diuji

Dari segi kesan kontak, ekstrak daun jagung peringkat puser awal tidak menyebabkan peningkatan pengekalan penahanan daripada parasitoid betina. Akan tetapi peningkatan kepekatan ekstrak dari peringkat lainnya, secara umum meningkatkan pengekalan penahanan parasitoid; peringkat berjambul pada kepekatan 0.03 g/ml menunjukkan perbezaan yang amat bererti. Ekstrak permukaan dari *A. hybridus* menunjukkan peningkatan pengekalan penahanan yang bererti. Ekstrak dari *C. rutidosperma* tidak menyebabkan sebarang perbezaan yang bererti manakala dari *A. gangetica* menyebabkan perbezaan yang bererti hanya pada kepekatan tertinggi yang diujikan. Sebaliknya, ekstrak *Ageratum* meningkatkan pengekalan penahanan oleh parasitoid betina dengan bererti.

Parasitoid betina yang diberi kesempatan untuk bertelur sebelum digunakan dalam kajian menunjukkan pengekalan penahanan yang lebih dalam kajian

piring Petri. Kajian pemparasitan menunjukkan bahawa ekstrak dari daun jagung dan rumpai *A. gangetica*, dan *A. hybridus* meningkatkan pemparasitan telur *Corcyra cephalonica* oleh *T. papilionis*. Rangsangan prapelepasan parasitoid dengan mengguna ekstrak daun jagung dan *A. hybridus* menyebabkan peningkatan kadar pemparasitan. Kajian di lapangan mendapat hasil yang tidak dapat disimpulkan kerana bilangan parasitoid yang rendah yang luar biasa pada saat kajian dilakukan. Akan tetapi, prestasi *Trichogramma* di lapangan nampaknya dipertingkatkan dengan aplikasi ekstrak *A. hybridus*.

Disimpulkan bahawa *T. papilionis* nampaknya telah dapat menyesuaikan diri terhadap bahan kimia dari tanaman jagung, tanaman perumah semula jadi *O. furnacalis*. Responnya, akan tetapi berbeza mengikut peringkat tumbesaran tanaman. Respon *T. papilionis* terhadap ekstrak dari *A. hybridus* adalah positif dan sebanding dengan yang disebabkan oleh ekstrak daun jagung. Oleh kerana respon *T. papilionis* berbeza-beza terhadap jenis-jenis rumpai yang terdapat dalam ekosistem tanaman jagung, penyiangan rumpai secara terpilih akan meningkatkan prestasi parasitoid tersebut. *Amaranthus hybridus* memiliki prospek untuk dimanfaatkan dalam manipulasi perilaku pencarian *T. papilionis* bagi tujuan pengawalan pengorek batang jagung dan berkemungkinan menjadi jambatan penghubung *T. papilionis* dengan Lepidoptera perosak dalam sistem

tanaman lainnya. Akan tetapi, kajian lebih lanjut diperlukan dari segi kaedah yang digunakan.

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I certify that an Examination Committee has met on February 14, 2006 to conduct the final examination of Saripah Ulpah on her Doctor of Philosophy thesis entitled "Behavioral Responses of *Trichogramma papilionis* Nagarkatti, Egg Parasitoid of Maize Borer, *Ostrinia furnacalis* (Guen.), to Semiochemicals from Maize Plant and Selected Weeds" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



SARIPAH ULPAH

Date: 9 March, 2006

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	vii
ACKNOELEDGEMENTS	xii
APPROVAL	xiv
DECLARATION	xvi
LIST OF TABLES	xxi
LIST OF FIGURES	xxii
GLOSSARY OF TERMS	xxv
 CHAPTER	
1 INTRODUCTION	1.1
1.1 The Objectives of the Study	1.7
1.2 The Overall Hypotheses	1.8
 2 LITERATURE REVIEW	2.1
2.1 Tritrophic System	2.1
2.2 Biological Control with Parasitoid <i>Trichogramma</i> .	2.3
2.3 Species of the Parasitoid, <i>Trichogramma papilionis</i>	2.5
2.4 Behaviour of <i>Trichogramma</i>	2.6
2.5 Host Finding Behaviour of Parasitoid	2.6
2.6 Source of Infochemicals Utilized by Parasitoid in Searching for Hosts.	2.8
2.7 Habitat Preference of <i>Trichogramma</i>	2.12
2.8 Semiochemicals and Their Effects on <i>Trichogramma</i>	2.13
2.9 Variation Response in Individual Parasitoid	2.17
2.10 Semiochemical and Learning in Parasitoids	2.18
2.10.1 Increasing Search Efficiency Through Learning	2.20
2.10.2 Persistency Effects of Parasitoid Experience	2.21
2.11 Chemistry of Semiochemicals Related to <i>Trichogramma</i>	2.21
2.11.1 Plant State Release Different Volatile	2.23



	2.11.2 Phytochemistry of Maize Plant and the Selected Weeds	2.24
3	GENERAL METHODOLOGY	3.1
	3.1 Stock Culture of <i>Corcyra cephalonica</i> and <i>Trichogramma papilionis</i>	3.1
	3.2 Plant Materials Used as Sources of Stimuli	3.2
	3.3 Solvent Used for Plant Extract	3.3
	3.4 Experimental Condition	3.3
	3.5 Experimental Design and Data Analysis	3.4
4	EFFECTS OF VOLATILE SEMIOCHEMICALS FROM MAIZE LEAF EXTRACTS AND FRESH PLANT MATERIAL OF SELECTED WEEDS ON <i>T. PAPILIONIS</i>	4.1
	4.1 Introduction	4.1
	4.2 Materials and Methods	4.4
	4.2.1 Experiment 1. Effect of Maize Leaves Extracts on <i>T. papilionis</i> in Linear Olfactometer	4.4
	4.2.2 Experiment 2. Effect of volatile Semiochemicals from Fresh Plant Material Of Selected Weeds on <i>T. papilionid</i> in Linear Olfactometer	4.7
	4.3 Results	4.8
	4.3.1 Experiment 1.	4.11
	4.3.2 Experiment 2.	4.19
	4.4 Discussion	4.24
	4.5 Conclusions	4.32
5	EFFECTS OF SEMIOCHEMICALS FROM MAIZE PLANT AND ASSOCIATED WEEDS ON PARASITIZATION RATE BY <i>TRICHOGRAMMA PAPILIONIS</i>	5.1
	5.1 Introduction	5.1
	5.1.1 Objectives	5.2
	5.2 Materials and Methods	5.3
	5.2.1 Experiment 1. Effects of Extracts of Maize Leaf and Selected Weed on Parasitization Rate by <i>T. papilionis</i>	5.3
	5.2.2 Experiment 2. Effects of Maize Plant and Associated Weeds on Parasitization Rate by <i>Trichogramma papilionis</i>	5.7

5.3	Results	5.9
5.3.1	Petri Dish Testing through Spot Treatment	5.9
5.3.2	Petri Dish Testing through Blanket Treatment	5.10
5.3.3	Parasitization through Cage Experiment	5.14
5.4	Discussion	5.17
5.5	Conclusions	5.24
6	CONTACT EFFECTS OF PLANT SEMIOCHEMICALS ON THE RETENTION TIME AND LOCOMOTORY BEHAVIOUR OF <i>T. PAPILIONIS</i>	6.1
6.1	Introduction	6.1
6.1.2	Objectives	6.3
6.1.3	Hypotheses	6.3
6.2	Materials and Methods	6.3
6.2.1	Experiment 1. Effects of Contact Plant Semiochemicals on the Retention Time of <i>T. papilionis</i>	6.3
6.2.2	Experiment 2. Effects of Contact Plant Semiochemicals on the Locomotion Behaviour of <i>T. papilionis</i>	6.5
6.3	Results	6.8
6.3.1	Experiment 1. Effects of Contact Chemicals on Retention Time	6.8
6.3.2	Experiment 2. Effects of Contact Chemicals on Locomotion Behaviour	6.11
6.4	Discussion	6.15
6.5	Conclusions	6.20
7	EFFECT OF SEMIOCHEMICAL STIMULATION AT TIME OF RELEASE ON IMPROVING EFFICIENCY OF <i>T. PAPILIONIS</i>	7.1
7.1	Introduction	7.1
7.2	Objective	7.3
7.3	Materials and Methods	7.3
7.4	Results	7.6
7.5	Discussion	7.7
7.6	Conclusions	7.10

8	FIELD ASSESMENT OF APPLICATION OF EXTRACT OF <i>AMARANTHUS HYBRIDUS</i> ON EGG PARASITISM BY <i>TRICHOGRAMMA PAPILIONIS</i>	8.1
8.1	Introduction	8.1
8.2	Materials and Methods	8.3
	8.2.1 Study site and Field Preparation	8.3
	8.2.2 Pretreatment Assessment	8.4
	8.2.3 Method of Extraction	8.5
	8.2.4 Treatment Application	8.5
8.3	Results	8.8
8.3.1	Field I	8.8
8.3.2	Field II	8.13
8.4	Discussion	8.17
8.5	Conclusions	8.20
9	GENERAL DISCUSSION AND CONCLUSIONS	9.1
	REFERENCES	R.1
	APPENDICES	A.1
	BIODATA OF THE AUTHOR	B.1

LIST OF TABLES

Table	Page
4.1 Regression Coefficient (β) of Mean of Attraction Indices of Volatiles from Maize Leaf Extracts of Several Stages and Control to <i>T. papilionis</i> .	4.18
4.2 Regression Coefficient (β) of Mean of Attraction Indices of Volatiles from Fresh plant Material and Control to <i>T. papilionis</i> .	4.24
5.1 Parasitism by <i>Trichogramma papilionis</i> on <i>Corcyra</i> egg card treated with surface extract of corn-leaf and <i>Amaranthus</i> sp.	5.10
5.2 Parasitization by <i>T. papilionis</i> obtained for one hour exposure of <i>Corcyra</i> eggs treated with <i>Ageratum conyzoides</i> leaf surface extracts.	5.10
5.3 Parasitism by <i>T. papilionis</i> obtained for one hour exposure of <i>Corcyra</i> eggs treated with leaf surface extracts of several weeds species at three concentrations and controls	5.13
5.4 Parasitization by <i>T. papilionis</i> obtained for one hour exposure of <i>Corcyra</i> eggs treated with <i>Ageratum conyzoides</i> leaf surface extracts	5.13
6.1 Mean time required by <i>T. papilionis</i> female to reach ceiling Arena of cylinder glass when exposed to extracts of maize treated filter paper and control.	6.9
6.2 Mean time required by <i>T. papilionis</i> female to reach ceiling Arena of cylinder glass when exposed to surface extracts of maize and weeds treated filter paper and control.	6.10
6.3 Average distance traveled per 5 sec. by experienced <i>T. papilionis</i> female on the filter paper partially treated with plant surface extracts.	6.12

- 6.4 Average distance traveled per 5 sec. by inexperienced *T.papilionis* female on the filter paper partially treated with plant surface extracts. 6.13

LIST OF FIGURES

Figure		Page
1.1	A multi-trophic situation where the parasitoid might utilize the source of chemical cues	1.6
1.2	Illustration on how semiochemicals may contribute to enhancement of parasitoid performance in the field	1.8
3.1	Maize Plant development as described in U.S.D.A. Technical Bulletin	3.5
3.2	Weed species used in the study	3.6
4.1	Linear Olfactometer Set up	4.10
4.2	Response of <i>T. papilionis</i> in linear olfactometer to volatiles from extracts of maize leaf at early-whorl stage A. 0.005 gr/ml B. 0.05 gr/ml	4.13
4.3	Response of <i>T. papilionis</i> in linear olfactometer to volatiles from extracts of maize leaf at mid-whorl stage A. 0.005 gr/ml B. 0.05 gr/ml	4.14
4.4	Response of <i>T. papilionis</i> in linear olfactometer to volatiles from extracts of maize leaf at late whorl stage A. 0.005 gr/ml B. 0.05 gr/ml	4.15
4.5	Response of <i>T. papilionis</i> in linear olfactometer to volatiles from extracts of maize leaf at tasseling/silking stage A. 0.005 gr/ml B. 0.05 gr/ml	4.15
4.6	Response of <i>T. papilionis</i> in linear olfactometer to volatiles from extracts of maize leaf at maturing stage A. 0.005 gr/ml B. 0.05 gr/ml	4.17
4.7	Response of <i>T. papilionis</i> to volatiles from fresh plant material of (A) <i>A. intrusa</i> , (B) <i>C. rutidosperma</i> and (C) <i>A. hybridus</i> in linear olfactometer	4.20

4.8	Response of <i>Trichogramma papilionis</i> to volatiles from fresh plant material of (A) <i>Amaranthus hybridus</i> and (B) <i>Ageratum conyzoides</i>	4.21
4.9	Responses of <i>T. papilionis</i> to volatiles from fresh plant material of (A) <i>B. latifolia</i> and (B) <i>C. rotundus</i>	4.22
4.10	Responses of <i>T. papilionis</i> to volatiles from fresh plant material of <i>E. indica</i> in linear olfactometer	4.23
5.1	Arrangement of egg-cards for parasitism testing with spot treatment.	5.5
5.2	Petri dish containing filter paper showing the position of three clusters of <i>Corcyra</i> eggs exposed to <i>Trichogramma</i> females for parasitism testing.	5.6
5.3	Set up of cage experiment to test for parasitism by <i>T. papilionis</i>	5.8
5.4	Means ^a of Parasitization by <i>T. papilionis</i> on <i>Corcyra</i> eggs treated with surface extracts of maize leaf of various stages at three concentration, exposed for 3 h	5.12
5.5	Parasitization by <i>T. papilionis</i> on <i>Corcyra</i> eggs treated with surface extracts of several weeds associated with corn plant at three concentrations, exposed for 3h.	5.15
5.6	Means ^a parasitization by <i>T. papilionis</i> on <i>Corcyra</i> egg cards placed on different plant species and control	5.16
6.1	The cylinder arena for evaluating effects of contact chemical on phototactic suppression <i>T. papilionis</i>	6.5
6.2	Filter paper with a marked patch formed by deposition of 0.5 mL extract or hexane on 15 cm diameter filter paper	6.6